4. Repeat photography for studies on environmental changes and geomorphological processes in northern Ethiopia

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The illustrative power of a set of repeat photographs is often stronger than that of other scientific output, but historical photographs are also a very useful research tool and object themselves (Fig. 1).

Fig. 1a. Dessie and Tossa Amaba around 1907 (Photo Vanini © Italian Military Geographical Institute, Firenze)

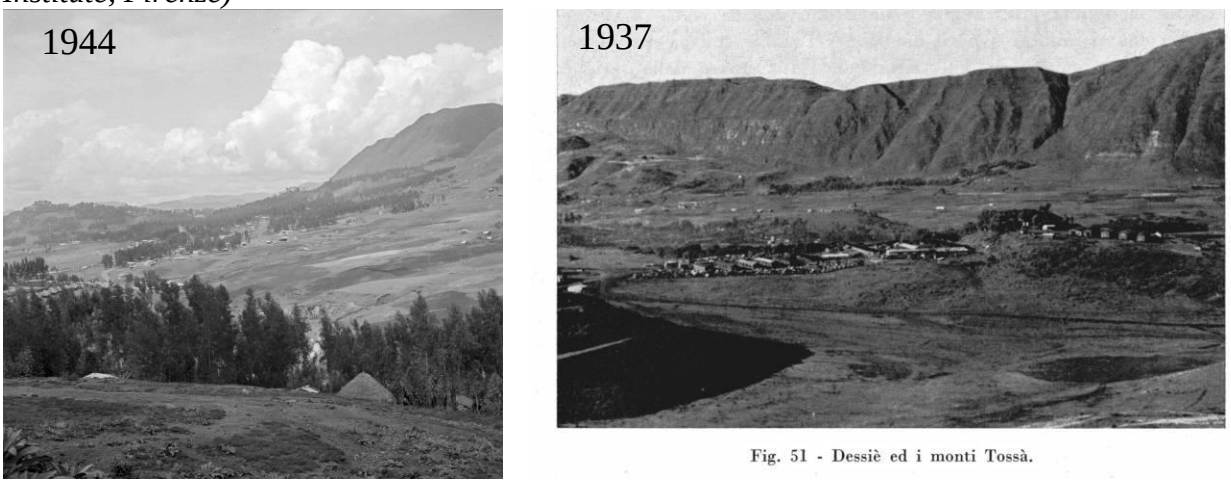

Fig. 1b. Dessie and Tossa Amaba around 1940. Left: 1944 (Photo D. Buxton); right 1937 (Gortani and Bianchi, 1973)

Among the digital archives with historical photographs of Ethiopia that we accessed, some hold fully digitised databases including downloadable photographs (of variable resolution); others show only part of the digital imagery available but have a possibility of ordering other photographs online; still others basically display a few photographs to give an idea about the collection and further clearly state procedures for on-site selection visits as well as ordering of scanned photographs (Nyssen *et al.*, 2010a).

Fig. 2. Map of the Abyssinian expedition (Nyssen et al., 2009)

As the name implies, repeat photography means retaking photographs from the same spot and of the same subject several times; it requires precise repositioning of the camera and composition of the subject, typically the distant landscape (Nyssen *et al.*, 2010b). The relocation of historical photographs in Ethiopia was based on rough indications on some of the photographs, detailed scrutiny of maps with routes taken by the original photographers – for instance the "Abyssinian expedition" in 1868 (Fig. 2), knowledge of landscape forms induced by various lithologies, screening of the 3-dimensional landscape using Google Earth, and a fifteen-years long geomorphic research experience in the study area.

First, the approximate camera position was obtained by identification of unique landscape features such as mountain peaks, drainage ways and their relative position. Finally, the exact camera position and orientation was obtained by lining up near and distant objects in a triangulation system. However, not all photographs could be repeated; some particular problems concerned the absence of identifiable objects.

In Ethiopia, repeated photographs have been used for qualitative analysis, such as the Simien mountains study (Nievergelt, 1998), to illustrate land use and cover changes that were identified using other techniques, or to verify some common perceptions, such as that of a 40% forest and vegetation cover in the northern highlands of Ethiopia in the early 20th century (Crummey, 1998, 2001). This perception has been challenged earlier on, on the basis of historical and stratigraphic evidence; however to challenge a perception, photographic evidence is a strong argument (Fig. 3).

Though repeat photography is more commonly used in qualitative studies, it can also be used in a quantitative way, such as our studies that compared land degradation and a soil erosion assessment between 1975 and 2008 (Munro *et al.*, 2008; Nyssen *et al.*, 2008), changes in gully volumes (Frankl *et al.*, 2011) and historical land use mapping (de Mûelenaere *et al.*, 2011; Meire *et al.*, 2011).

As an example, the methodology is presented that was applied to study environmental changes in the north Ethiopian highlands since the late 19th century. Landscape photographs taken during the "Abyssinia expedition" in 1868 were obtained from the Kings Own Museum. Thirteen landscapes photographed in early 1868 (dry season) were re-visited in the same season in 2008 and a new set of photographs prepared. They covered a north-south transect between the Red Sea coast and Maqdala (Fig. 2) and provided a fair representation of the 1868 landscape. The location of the interpreted landscapes was assumed to be random, insofar that the photographers

in 1868 could not foresee environmental changes that would take place in these areas, or had occurred before.

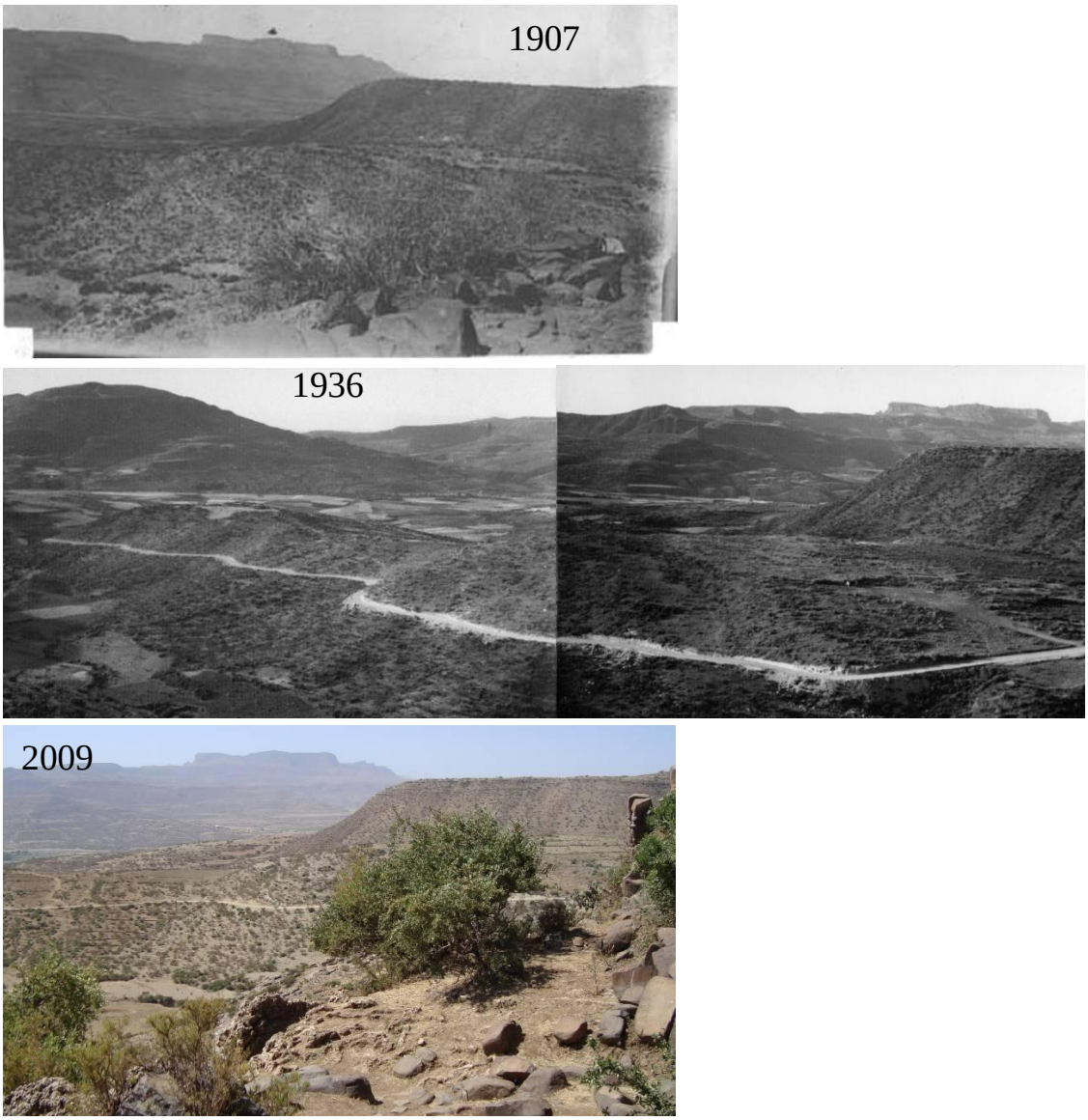

Fig. 3. Amba Aradom mountain seen from the North in 1907 (top), 1936 (middle, under a slightly different angle) and 2009 (bottom) (Nyssen et al., 2010a). These photographs are not exact matches, but are very useful in revealing changes through the years; it is called an "incidental time series". The landscape portrayed on the 1907 and 1936 photographs is remarkably similar to the current one, a fact which appears on many of the historical photographs. Such photographs hopefully contribute to demythify common beliefs in the area that the shrubs which are currently visible evidence that 'at the time of our grandfathers all this area was forest'. 1907 photograph Vanini © Italian Military Geographical Institute, Firenze; 1936 photograph A. Maugini © Istituto Agronomico per l'Oltremare, Firenze; 2009 photograph © Jan Nyssen.

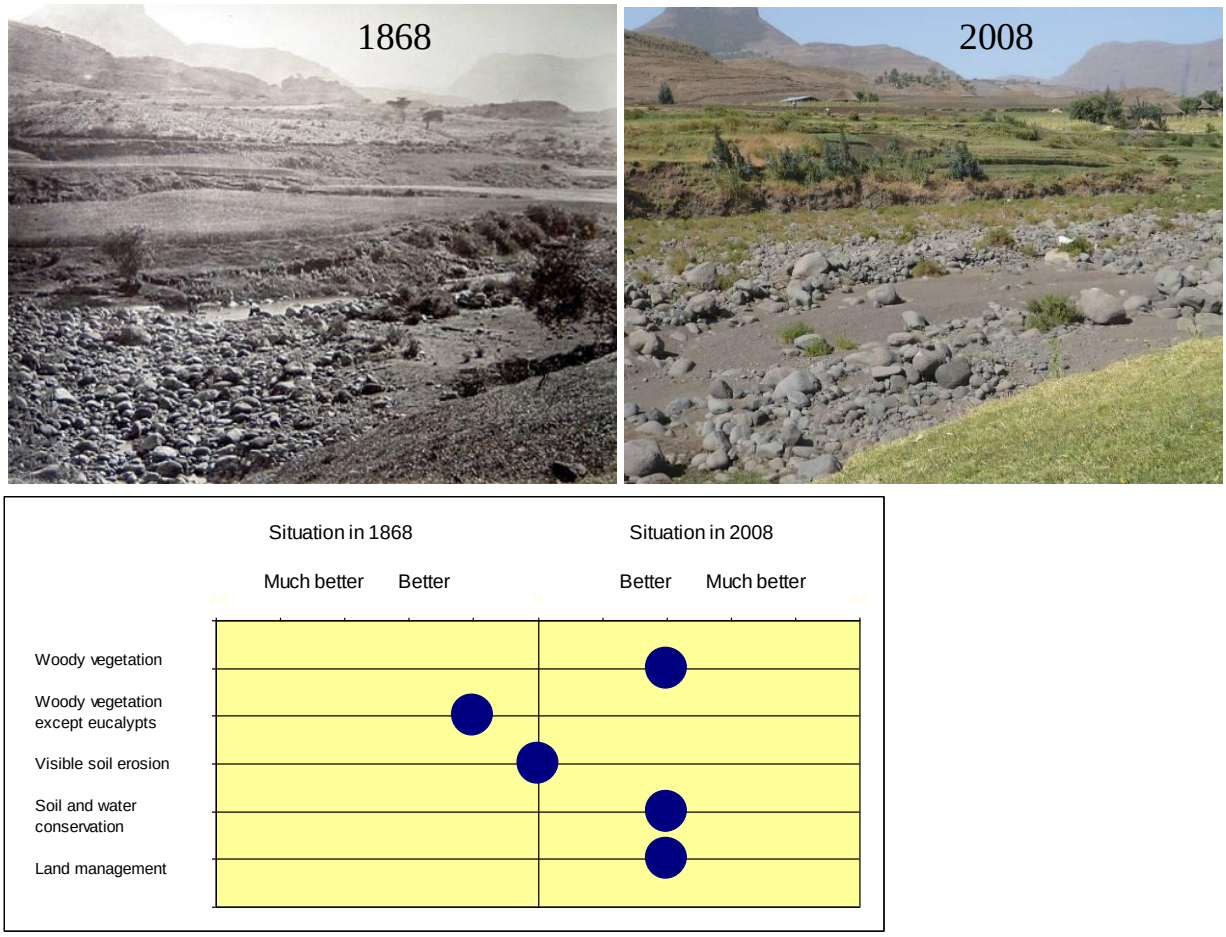

Fig. 4. The left photograph was taken in 1868 near the source of Tacazze River, one of the main rivers draining the Ethiopian highlands to the Nile. The river terrace in the centre of the 1868 photograph is cropped with wheat or barley which were commonly irrigated crops at that time (Markham, 1868), unlike nowadays when irrigation is mainly used for marketable vegetables. By 2008 (right photograph), the river terrace has completely been eroded away. More steep slopes are cultivated nowadays, which explains why there are more lynchets (cultivation terraces). The aspect of the slope in the middle of the photographs has completely changed because of these terracing practices. Furthermore, the land use did also change, from rangeland to cropland. The graph represents the medians of change evaluations by eight international experts (Nyssen et al., 2009). 1868 photograph © King's Own Royal Regiment Museum; 2008 photograph © Jan Nyssen.

For that study (Nyssen *et al.*, 2009), the photographs (historical photographs and repeats) were shown to eight scientists with longstanding research experience on geomorphology and land management in Ethiopia and elsewhere. Only photocouples, taken at exactly the same place, in the same season and under the same angle were considered. The immediate foreground is dependent on the exact position of the photographer. To avoid bias, it was masked for the analysis, unless it had clear reference points.

The repeat photography analysis involved comparing on-the-ground conditions of 2008 (presented as black and white photographs) to photographs depicting the 1868 conditions,

whereby scores were assigned by the experts. Given that the scoring method used ordinal variables, the median score per indicator was calculated for every photo-couple, provided that at least four of the eight experts thought the indicator relevant for the photo-couple. Averages of the median scores were then calculated for each indicator, for the whole set of time-lapsed photographs. The deviation of the averages from zero (no change) was tested with the Wilcoxon signed-rank test. This study of landscape re-photography covering 140 years of change showed that the status of natural resources in northern Ethiopia was very degraded in 1868, and has since then either remained in a status that is similar (Fig. 4), or has improved, or has in some areas greatly improved (Nyssen et al., 2009).
To allow the participants to verify changes by themselves, historical photographs taken from a dozen different viewpoints of this excursion are included in the excursion guide as reference material (Fig. 5 and Table 1).

Fig. 5. Half way Dessie and Alamata in 1944. Photo D. Buxton. (Nyssen et al., 2010)

Table 1. Historical landscape photographs appearing further in the excursion guide
- Tita (1937; 1997), on p 24 and 25.
- Gra Kahsu (1939; 1975; 1991), on p. 36.
- Lake Ashenge (1939; 1975), on p. 40.
- Atsela pass to Ferrah Amba (1942), on p. 46.
- Atsela plain (1937; 1975), on p. 40.
- Amba Aradom (1868), on p. 64.
- May Makden, (1974; 1994), on p. 41.
- Wukro, near rock church (1937), on p. 146.
- Senkata (1975), on p. 160.
- Adwa volcanic plugs (1974), on p. 170.

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